PRS: Physics Reconstruction and Selection
HCAL/JetsMET group

Status of JetsMET

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18-Sep-2001

HCAL/JetsMET Group

S.Eno / S.Kunori - Coordinator

http://home.fnal.gov/~sceno/jpg/Default.htm

Dates:

End 2002 DAQ TDR (end 2001 for HLT section)
End 2004 Physics TDR

Organization:

HCAL simulation – Sunanda Banerjee (TIFR)
- CMSIM/GEANT4/FAST
- Verify shower model in G4.

Calibration & Monitoring – Olga Kodolova (MSU)
- energy scale of jets, MET, tau
- -> from detector construction/commission to in-situ calibration.

HCAL in ORCA – Salavat Abdullin (Maryland)
- readout simulation + …

Physics objects with HCAL – Sasha Niketenko (CERN/ITEP)
- jets, MET & tau

HLT for τ-jets /Jets / MET

$\tau^+ \rightarrow \pi^+\nu$	12.5%
$\tau^+ \rightarrow \rho^+\nu \rightarrow \pi^+\pi^0\nu$	26%
$\tau^+ \rightarrow a_1\nu \rightarrow \pi^+\pi^0\pi^0\nu$	7.5%

τ-jets

Narrow jet (similar to electron)

BG: QCD jets

→ Refine narrowness

→ Identify 1/3 charged tracks

L2: ECAL full segmentation

L3: Pixel (see Lucia's talk)

Jets

BG: QCD jets

Fake (+ additional) jets due to pile-up (E_T<50GeV)

→ Improve energy scale and resolution

→ Remove fakes

MET

BG: badly measured QCD jets

b/c semi-leptonic decays (?)

→ Improve energy scale and resolution

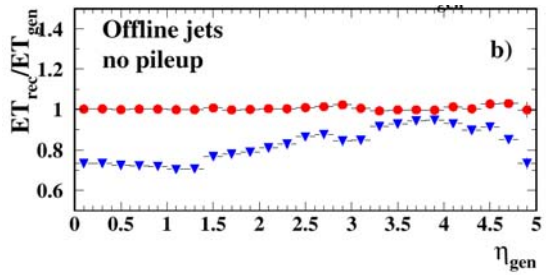
→ remove BG's.

Jet Response and Correction #1

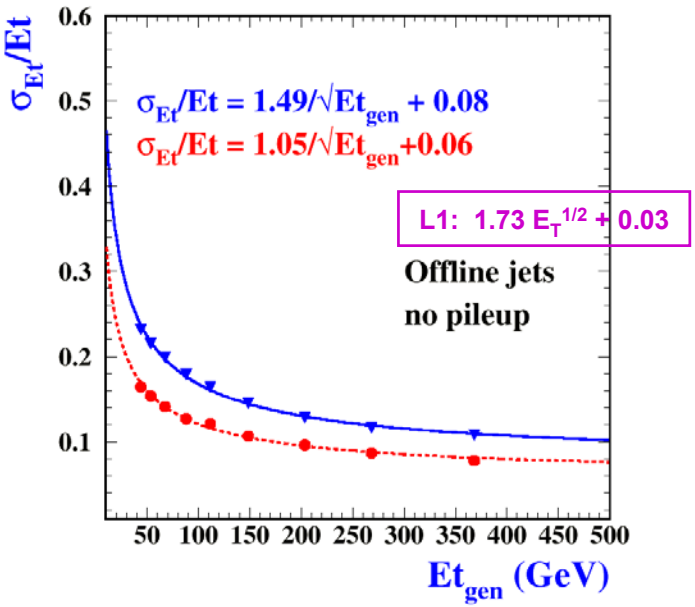
Et-eta dependent correction for QCD jets

$Et(corr)=a + b \times E_T(rec) + c \times E_T(rec)^2$

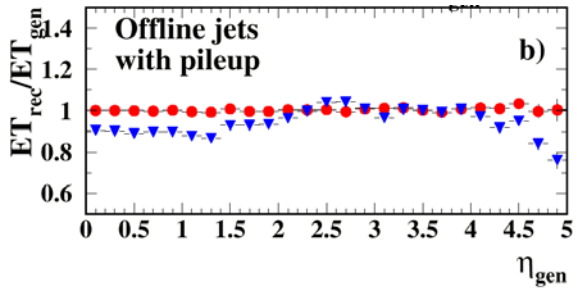
No pileup



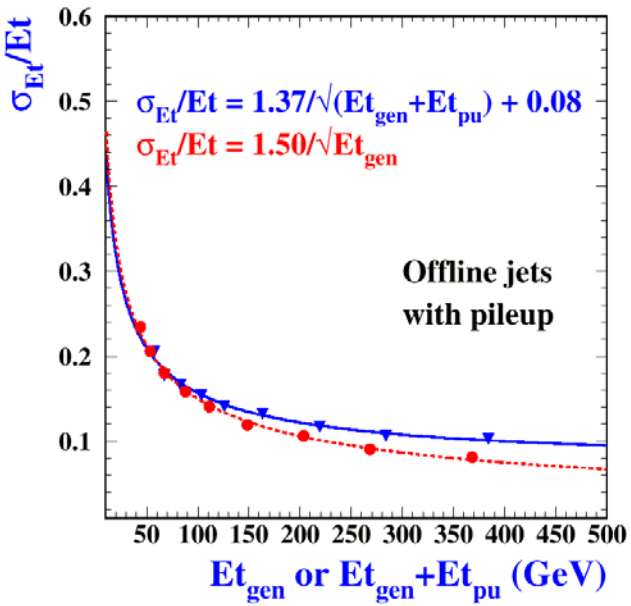
Offline Jets resolution, |η|<5



With pileup



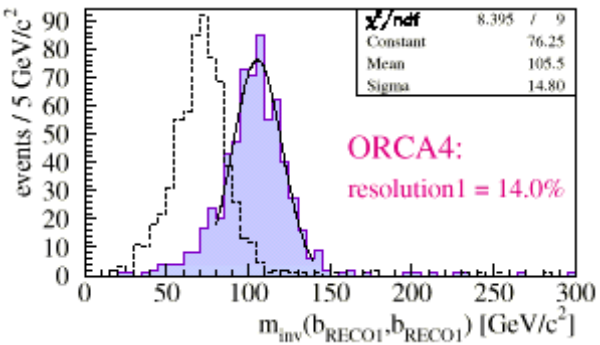
Offline Jets resolution, |η|<5



Dijet Mass Resolution

No pileup

M(bb) in ttH



Jet energy correction

without: 19%

with: 14%

CMSJET 15%

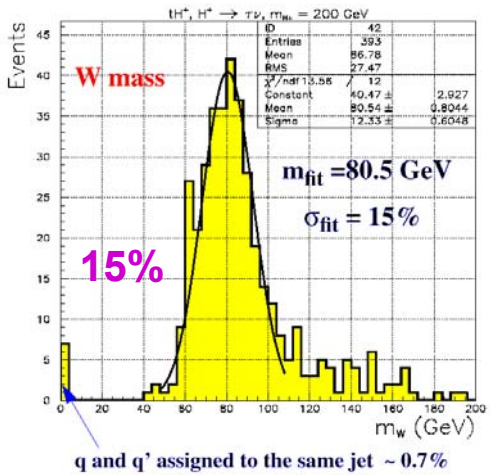
(S.Arcelli & V.Drollinger)

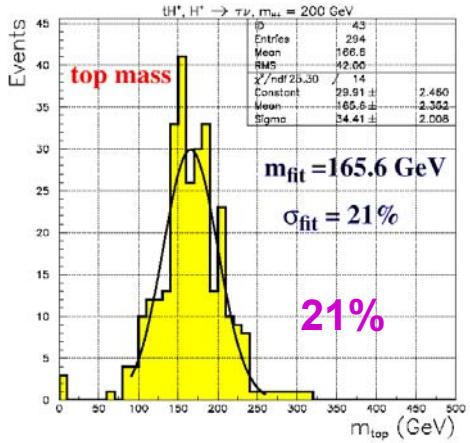
With pileup

W(jj)

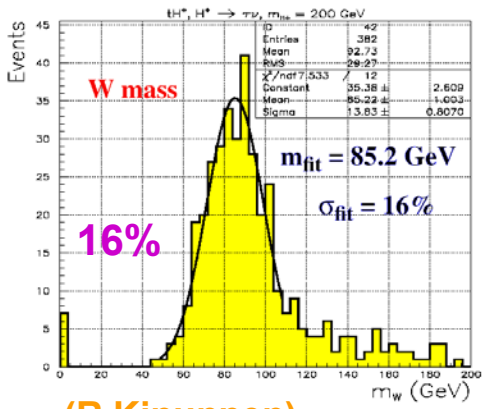
Top(jjj)

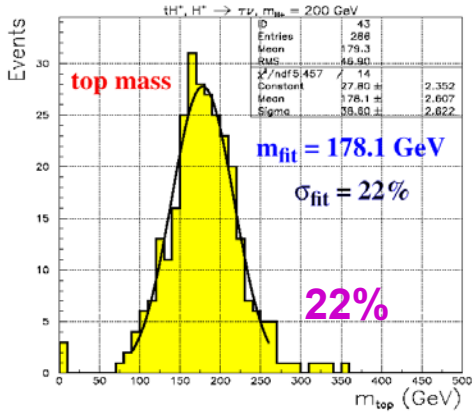
Before correction





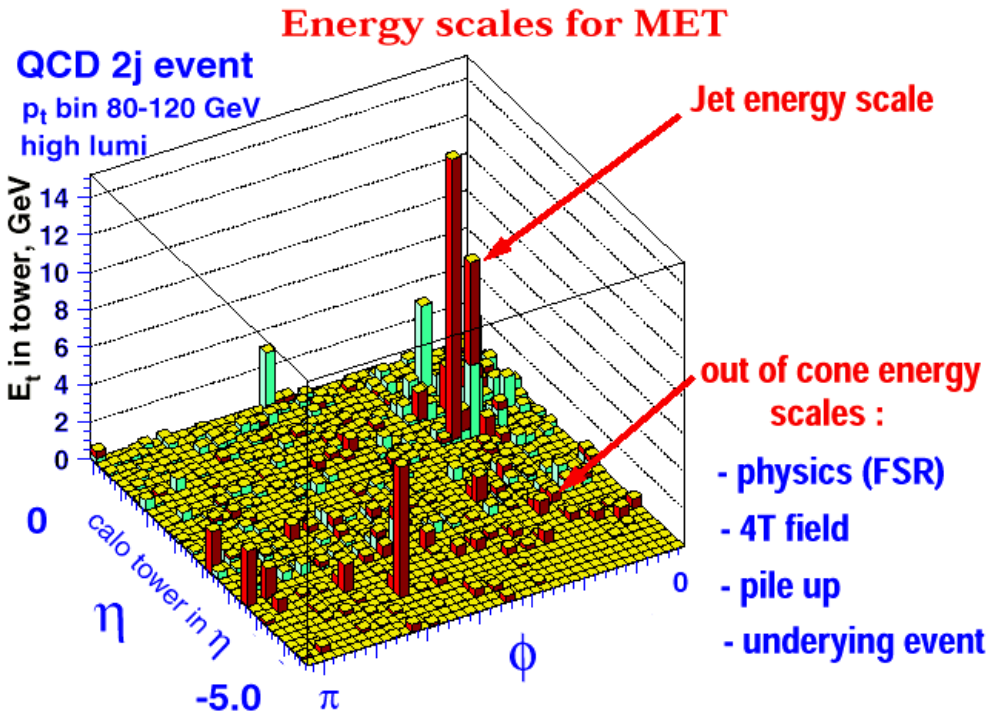
After correction



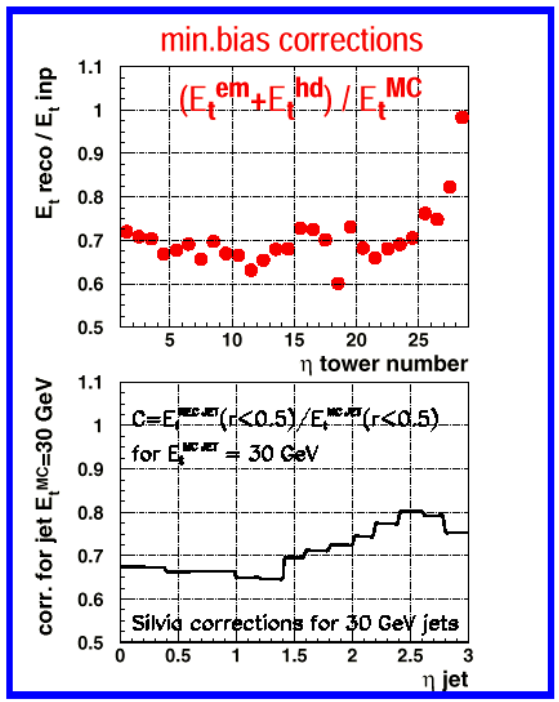


(R.Kinunnen)

MET



Out of cone corr. uses weights for jet(30GeV) corr.



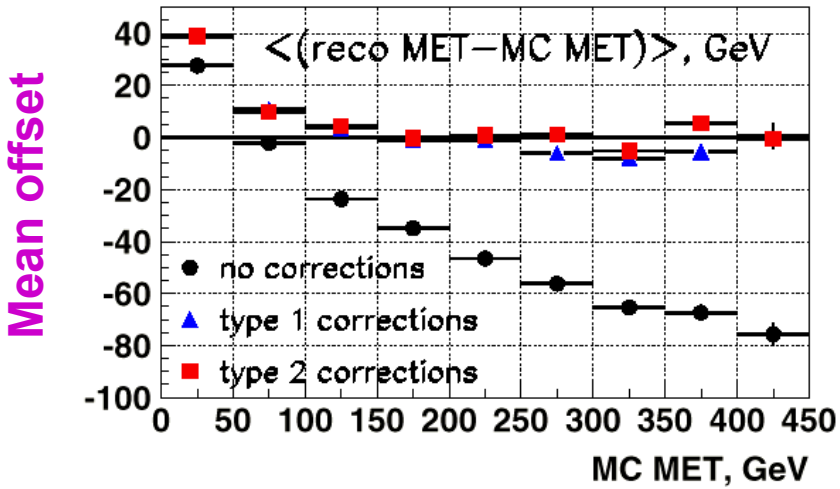
(Nikitenko)

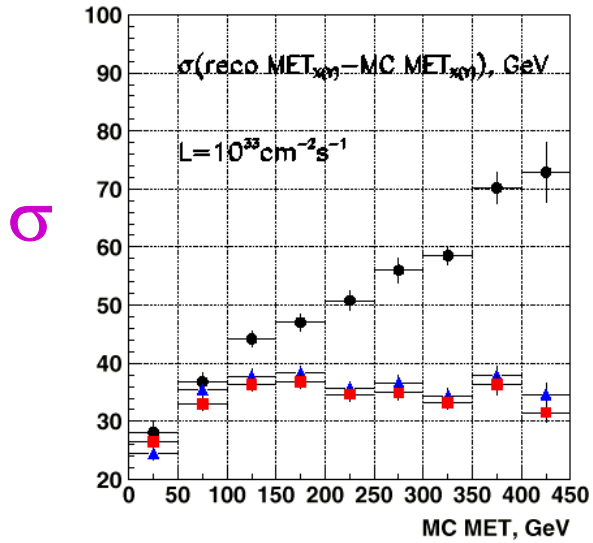
Corrections

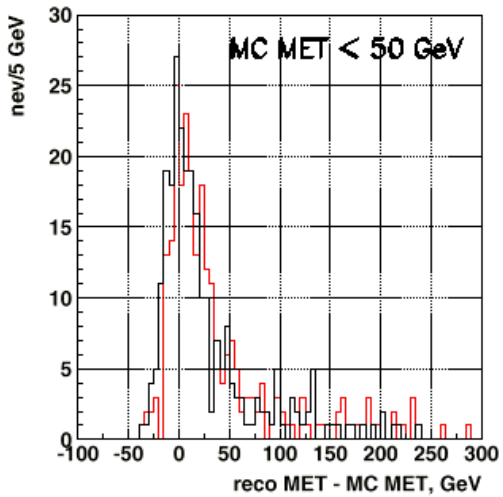
Type 1: Jet corr.

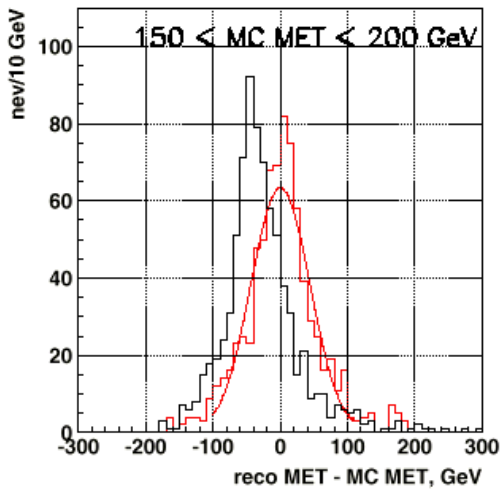
Type 2: Jet corr. + out of cone corr.

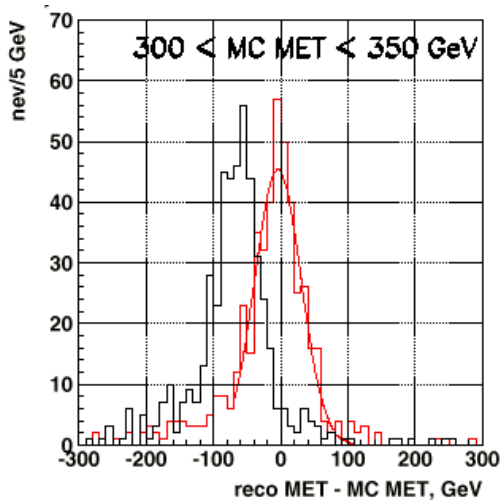
Corrected MET for mSUGURA Jets+MET at low lumi







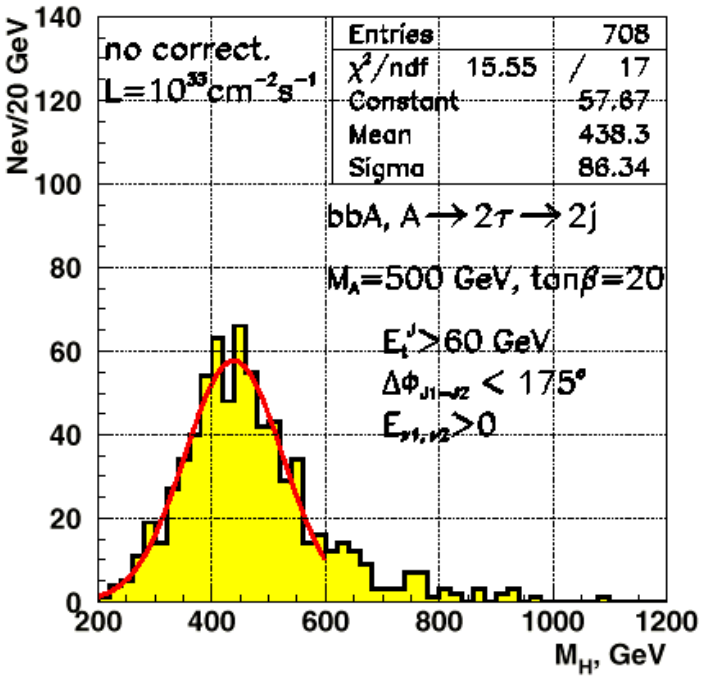




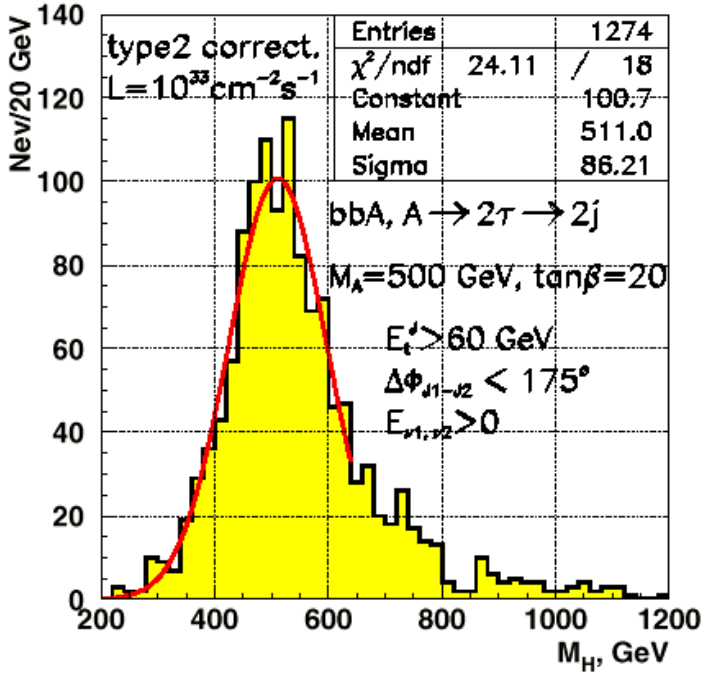
Higgs mass in bbA, A→2τ→2j

(A.Nikitenko)

before correction



after correction



bbA, A->2τ->2j	no corrections	type1 corrections	type2 corrections	CMSJET
$<M_H>$	438.3 GeV	500.3 GeV	511.0 GeV	500.0 GeV
$\sigma / <M_H>$	19.7 %	18.9 %	16.8 %	13.4 %
ε_{reco} (corr.) / (no corr)	1	1.53	1.80	

Corrections for Jet Energy

Two steps for HLT jets

1) Find jets with R=0.5-1.0 with fixed calorimeter weights.
2) Correct energy scale to sharpen turn on curve.

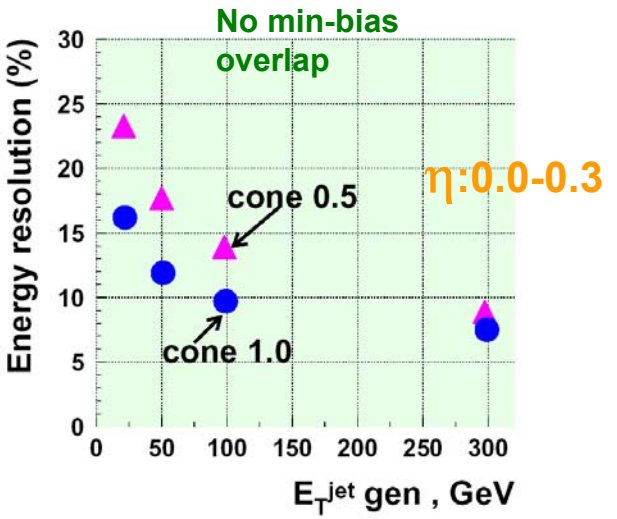
Energy Correction

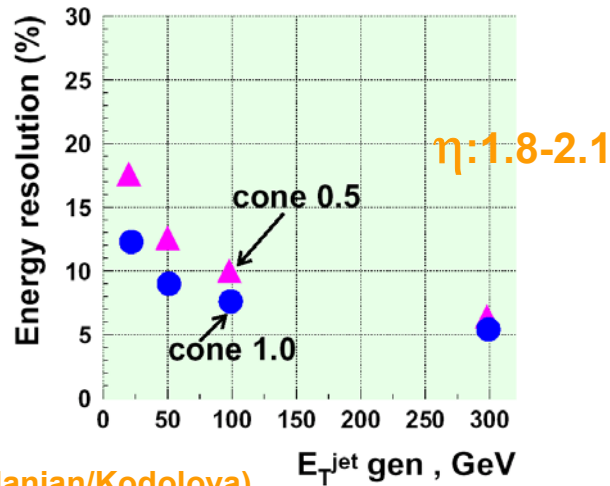
- **Jet based**
  1) E = a x (EC+HC), a depends on jet(ET,η)
  2) E = a x EC + b x HC, a, b depend on jet(ET,η)
- **Particle based**
  1) E = em + had (requires to separate em/had clusters) (#)
     em = a x EC for e/γ
     had = b x EC + c x HC, for had. b (c) depend on EC (HC)
- **Use of reconstructed tracks**
  1) E = E_0 + (Tracks swept away by 4T field) (#)
  2) E = EC(e/γ+neutral) + HC(neutral) + Tracks (#)

(#) Reports during the cms week.

Jet Cone Size

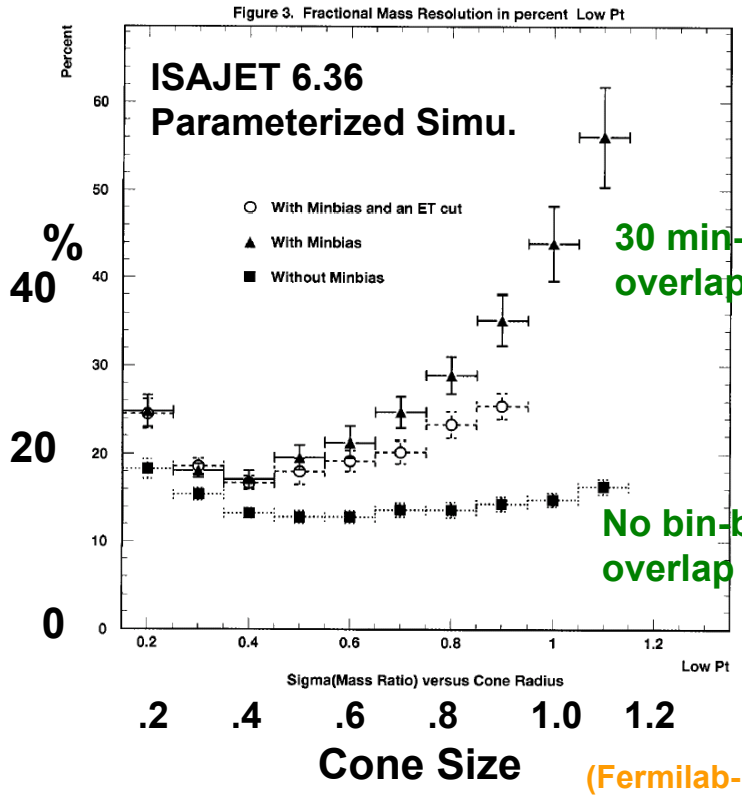
particle-jets vs. reco-jets





(Vardanian/Kodolova)

Resolution of Mass(Z→jj) - 1994 study -



(Fermilab-FN-626)

Larger R is better for di-jets @ low luminosity.
→ Need to test with multi jets.
→ @ high luminosity

Threshold & Readout simulation

Our study showed-

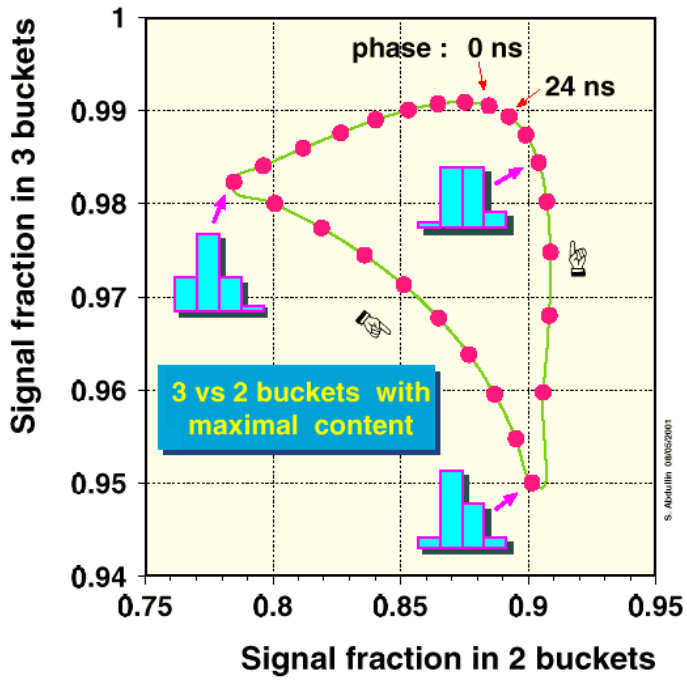
lower threshold on tower is better
for both jets and MET
(even at high luminosity).

→ E_T = 500MeV per HC tower
(and EC tower)

HCAL noise = 200MeV/ch/25nsec (SPICE)

→Minimize the number of beam buckets for signal extraction.

Signal correcion & phase



(S.Abdullin)

→ 2 buckets for signal and separate runs for pedestal.

Need to measure performance of real front end electronics and verify this conclusion!

What's next?

Production

- **Complete CMS120 production**
  - Fall 2000 production for 2x10E32
    - **ooDigi – done // Ntuple – done this week, hopefully.**
  - Spring production for 2x10E32
    - **In progress.**
  - Production for 10E34 with new front end elec. simu.
- **Prepare for next production**

HLT rates calculation

Improvement

- **Jets / MET**
  - Algorithm for better resolution and energy scale.
- **MET**
  - Algorithm to remove badly measured jet events.

→ **Algorithm for 10E34!**

Expanding group

We try to attract more people in the HCAL community and help them to get familiar with the CMS detector, CMS software and physics (analysis) at the LHC.

Assumption:

- geographical spread and diversity in skill level continue.

Strategy:

- lower the threshold for entering software development and data analysis.
- build a core software team for strong support (preferably in US).
- recruit experienced people to coordinate larger number of people.

Potential manpower:

- Universities in US, RDMS (not only ITEP and MSU), India, Turkey, Hungary…
- US CMS Software and Computing Project (Tier1 & CAS)

We need urgently

- Strong software support group / C++ experts
- Experienced people to guide other people (analysis, experiment)

and

- Optimization of production & analysis system
- Distribution of simulated events.

Additional Slides

Algorithm for L1 through Offline (1)

L1 – calorimeter only (coarse segmentation)

- **Resolution improvement**
  - Equalize calorimeter response with simple correction
    - **a x EC + b x HC, a,b depends on jet(ET,h)**
    - **a x (EC+HC), a depends on jet(ET,h)**
- **Fake Jets/Pileup jets rejection**
  - Threshold cut on a central tower in jets (seed cut)

L2 – calorimeter only (fine segmentation)

- **Resolution improvement**
  - Better energy extraction from ADC counts
  - Em/had cluster separation using transverse shower shape in crystals
- **Fake jet/Pileup jet rejection**
  - Use of transverse shower shape

Algorithm for L1 through Offline (2)

L3 – calorimeter plus pixel

- **Resolution improvement**
  - Pileup energy subtraction
    - **Estimation of energy flow from pileup events using pixel hits/tracks.**
- **Fake jets/Pileup jets rejection**
  - **Vertex information and jet pointing using pixel hits/tracks.**

Offline – calorimeter plus fully reco-ed tracks

- **Resolution improvement**
- **Fake jets/Pileup jets rejection**
  - → Jet and MET will be reconstructed with Tracks, EM clusters and HAD clusters.
  - → All tracks down to E_T~ 700MeV have to be reconstructed at 10E34!
- **Physics correction – e.g. correction for IFR/FSR.**
  - → In-situ calibration!

Possible Additional Algorithm

Jets

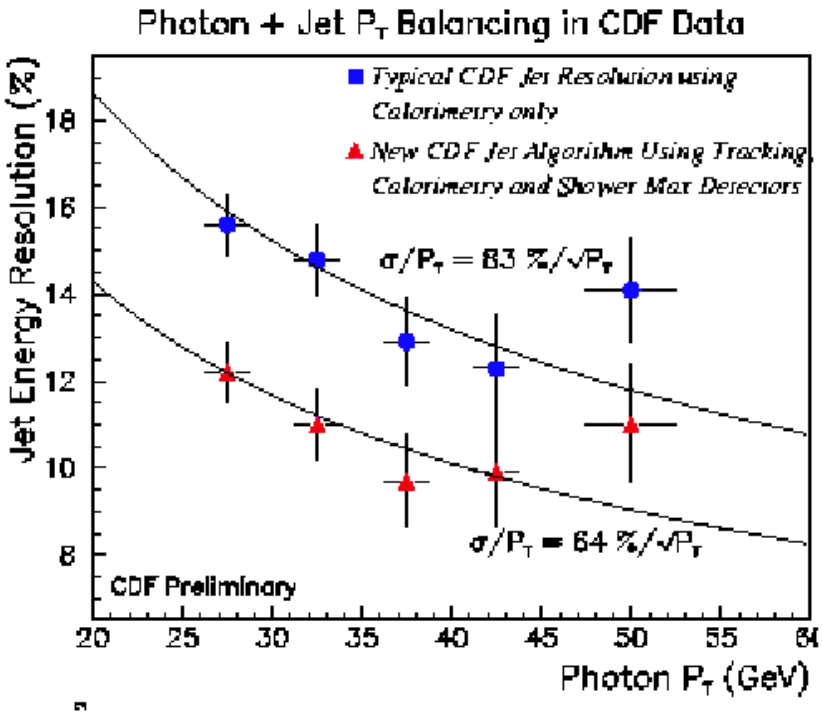
- $|\Delta\eta|$ (>3.5) cut for forward tagging jets (L1→)

MET

- $|\Delta\phi(\text{MET,JET})|$ cut (L2→)
- "SET" depending threshold (L2→)

Improvement of jet energy resolution with tracks

CDF



L3